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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 11 March 2002 with an application for Letters Patent number 517713 made by Deep Video Imaging Ltd..

I further certify that the Provisional Specification has since been postdated to 25 June 2002 under Section 12(3) of the Patents Act 1953.

Dated 7 July 2003.

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Patents Form No. 4

Provisional Specification

New Zealand Patents Act 1953

POST-DATED UNDER SECT 12(4)
to 25/6/2002

POST-DATED UNDER SECT. 12(3)
TO 28/6/02

Title: *Must be the same as the title on the Application for Patents (Patents form 1)*
Enhanced Viewing Experience of a Display through Localised Dynamic Control of Background Lighting Level

Applicant: *State (in full) name, address, and nationality of applicant or applicants*

I/We Deep Video Imaging Ltd.

Address Airport Road, Mystery Creek, RD2
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do hereby declare this invention to be described in the following statement: *(continue application on page 2)*

Please submit this form with the Application for Patent (Patents Form 1)

Field of Invention

This invention describes a method to enhance the viewing experience of a flat panel display of any video or still imagery through the localized dynamic control of the background lighting level of a specific area or areas of a scene or succession of video frames. This can be accomplished using a unique arrangement of two stacked flat panel displays, one of which would control backlight brightness values synchronized to appropriate areas within the scenes or images of the visual content being presented on the other display. This control could be provided over the video signal cable (DDC), serial, USB or a customized type of interface protocol.

Background Art

The frequency spectrum of radiation incident upon a detector depends on the properties of the light source, the transmission medium and possibly the properties of the reflecting medium. If one considers the eye as a detector the human visual system can sense radiation that has a wavelength between 0.6nm and 380nm. Hence this is described as the visual part of the electromagnetic spectrum. Humans perceive certain frequency distributions as having different colours and brightness. A scheme was devised to describe any perceived colour and brightness via adding three basis spectral distributions with various weights. For example in the 1931 CIE colour space any perceivable colour may be described by the following equation:

$$C = x_r X + y_r Y + z_r Z$$

Where C is the colour being described, Xr, Yr and Zr are the weights and X,Y and Z are 1931 CIE tristimulis curves which are graphs of the relative sensitivity of the eye Vs wavelength. For any given colour, the weights may be determined by the following equations:

$$x_r = \left(\int c(\lambda)\, x(\lambda)\, d\lambda \right)$$

$$y_r = \left(\int c(\lambda)\, Y(\lambda)\, d\lambda \right)$$

$$z_r = \left(\int c(\lambda)\, z(\lambda)\, d\lambda \right)$$

The 1931 co-ordinates are formed via the following normalisation:

$$x_r = \frac{X_r}{X_r + Y_r + Z_r}$$

$$y_r = \frac{Y_r}{X_r + Y_r + Z_r}$$

$$z_r = 1 - x_r - y_r$$

These may be plotted on the 1931 CIE diagram. The spectral locus defines the pure spectral colours, that is the perception of radiation with a specific

wavelength. Colour co-ordinates that are closer or farther from pure spectral colours are described as being more or less saturated respectively. The value of the y coordinate is also referred to as the luminance or the variable L. Pixels on a transmissive display, that is a display that provides its own light, will be capable of maximum and minimum luminous states. If one labels the maximum state as Lb and the minimum as Ld then the contrast ratio is described by

$$C_r = \frac{L_b}{L_d}$$

The perception model described above accurately predicts that colours on displays can be formed by mixing small areas of three basis colours with modulated intensities which are close in either close spatial or temporal proximity. If the basis colours are plotted on the CIE diagram then the enclosed triangle contains all the colours producible by the system. The enclosed area is called the colour gamut and hence a display with a larger area can display a greater variation in colour and has a greater colour gamut.

There are two main types of Liquid Crystal Displays used in computer monitors, passive matrix and active matrix. Passive-matrix Liquid Crystal Displays use a simple grid to supply the charge to a particular pixel on the display. Creating the grid starts with two glass layers called substrates. One substrate is given columns and the other is given rows made from a transparent conductive material. This is usually indium tin oxide. The rows or columns are connected to integrated circuits that control when a charge is sent down a particular column or row. The liquid crystal material is sandwiched between the two glass substrates, and a polarizing film is added to the outer side of each substrate.

A pixel is defined as the smallest resolvable area of an image, either on a screen or stored in memory. Each pixel in a monochrome image has its own brightness, from 0 for black to the maximum value (e.g. 255 for an eight-bit pixel) for white. In a colour image, each pixel has its own brightness and colour, usually represented as a triple of red, green and blue intensities. To turn on a pixel, the integrated circuit sends a charge down the correct column of one substrate and a ground activated on the correct row of the other. The row and column intersect at the designated pixel and that delivers the voltage to untwist the liquid crystals at that pixel.

The passive matrix system has significant drawbacks, notably slow response time and imprecise voltage control. Response time refers to the Liquid Crystal Displays ability to refresh the image displayed. Imprecise voltage control hinders the passive matrix's ability to influence only one pixel at a time. When voltage is applied to untwist one pixel, the pixels around it also partially untwist, which makes images appear fuzzy and lacking in contrast.

Active-matrix Liquid Crystal Displays depend on thin film transistors (TFT). Thin film transistors are tiny switching transistors and capacitors. They are arranged in a matrix on a glass substrate. To address a particular pixel, the proper row is switched on, and then a charge is sent down the correct column. Since all of the other rows that the column intersects are turned off, only the capacitor at the designated pixel receives a charge. The capacitor is able to hold the charge until the next refresh cycle. And if the amount of voltage supplied to the crystal is carefully controlled, it can be made to untwist only enough to allow some light through. By doing this in very exact, very small increments, Liquid Crystal Displays can create a grey scale. Most displays today offer 256 levels of brightness per pixel.

A Liquid Crystal Display that can show colours must have three subpixels with red, green and blue colour filters to create each colour pixel. Through the careful control and variation of the voltage applied, the intensity of each subpixel can range over 256 shades. Combining the subpixel produces a possible palette of 16.8 million colours (256 shades of red x 256 shades of green x 256 shades of blue).

Liquid Crystal Displays employ several variations of liquid crystal technology, including super twisted nematics, dual scan twisted nematics, ferroelectric liquid crystal and surface stabilized ferroelectric liquid crystal . They can be lit using ambient light in which case they are termed as reflective, or backlit and termed Tran missive. There are also emissive technologies such as Organic Light Emitting Diodes, which are addressed in the same manner as Liquid Crystal Displays. These devices are described hereafter as image planes.

No known reproduction process can exactly capture the original elements in a given situation (ie, the brightness of the sun shining down on a landscape). All colour reproduction systems can hope to do is replicate the relative differences between objects in the original view. The ratio of the whitest point to the blackest point in a scene is know as its dynamic range, which must be reproduced on some medium such as film, a CRT, an LCD, or paper. The characteristics of this medium, or its "native response," will determine the level of success a given reproduction achieves. The number of steps, or grayscale, into which this dynamic range can be subdivided determines the resolution of a particular primary colour. A typical monitor system will have the ability to display 8-bits, or 256 shades per primary colour for a total of over 16.7 million colours (256 x 256 x 256). This is known as the colour depth or image palette of the display system.

All display mediums, especially CRTs, introduce some amount of distortion,

which has to be corrected to make the reproduced image look "proper." The human eye sees logarithmically. To compensate for this, playback or image reproduction media must mimic the human visual response curve so that the display shows information in a way we are used to seeing. The resulting response curve varies in an exponential manner known as the "gamma curve" which is a polynomial equation describing any point on a curve native to a particular monitor. In a typical imaging system, the brightness changes very little at the lower energy grey levels causing some compression of the shadow detail where our eyes are the most sensitive. So instead of a straight-line, linear response where there is an equal amount of output for every value of input, the curve has a long, shallow beginning before it begins to climb.

Video or static images or scenes that are created, edited, stored, and then presented on flat panel media which displays them according to the luminance or brightness values which the author or editor imparts to them. Once they are imprinted and/or duplicated, further changes to the luminance properties of the content being displayed are only possible if applied to ALL the content. Until now, no method has been devised for controlling individual portions of a given scene, frame, or series of frames in a prescribed, dynamic fashion.

Disclosure of Invention

Methods are possible to one skilled in the art whereby the brightness of the display can be synchronized to the static or video image content being displayed on a flat panel device. Software can be written to examine the

grey scale content of a frame or a series of frames to compute, for instance, an arithmetic mean of the changing (dynamic) brightness level. Depending on present values from a given group of parameters, the software can cause instructions to be transmitted through a suitable application programming interface (API) to a backlight driver to dynamically adjust the brightness level of the display by controlling the voltage levels of lamp or lamps illuminating the display.

Adding the extra dimension of control imparted by a second display vertically stacked behind the panel displaying the video content allows this brightness adjustment to occur in a localized area or areas rather than being applied to the entire scene in a given frame. Appropriate and selective blockage of the backlight luminance level can be accomplished by applying variously darker neutral grey levels (at 50% transmission, for instance) to the pixels of the second display directly behind the portions of the scene one might wish to be de-emphasized or occluded. Conversely, the pixels behind areas of the image one wishes to be made brighter can be driven at grey levels corresponding to full or 100% transmission so as to allow all the backlight power to illuminate those areas.

In the first case where the backlight luminance is partially blocked, the gamma response curve of the pixels of the corresponding area on the display showing the video content may now be altered so as to increase their transmissivity. This increase, while not altering the net brightness level reaching the observer, will allow for an increased level of actinic stimulus of his visual cortex. Hence, by synchronously lowering the backlight brightness level and decreasing the gamma value of an image so that the same resultant luminance level is maintained, a more vibrant colour impact can be achieved than before possible with non-dynamic playback.

OTHER APPLICATIONS

In addition to brightness levels, recorded levels for image attributes such as hue, saturation, and colour temperature may also be present. The visual digital media applications that could be enhanced with this method include DV, HDTV, eCinema, DVD, QuickTime, AVI, RealVideo, etc; vector animation such as Flash; presentation software such as PowerPoint, slide-show software etc; tagged static image file formats such as JPEG or GIF images in web pages, PhotoCD, TIFF, PhotoShop, etc. Enhancements to the viewing experience described herein will be particularly valuable to the entertainment and publishing industries.